A Crossover Parametric Equation of State for Three-Dimensional Ising Universality Class Systems

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We have developed an extended parametric scaling representation of the equation of state for the universality class of the three-dimensional Ising systems which include fluids and fluid mixtures. The crossover from Ising-like behavior asymptotically close to the critical point to classical (van-der-Waals-like) behavior far away from the critical point has been incorporated into the parametric equation and is governed by two crossover parameters: the range of interaction and a molecular-size "cutoff". Explicit crossover expressions for the correlation length and the thermodynamic properties have been obtained. In the asymptotic limit, the crossover equation reproduces the most recent theoretical estimates for the universal ratios of the leading critical amplitudes. The correction-to-scaling amplitude ratios were found to be in good agreement with theoretical estimates as well. The equation has been tested on experimental data for ^{3}He and polymer systems and provides an excellent description of the data in an extended critical region. We have compared our new equation with other crossover equations of state. The equation also describes the numerical simulation data for the crossover critical behavior of the susceptibility and the order parameter for three-dimensional Ising lattices with various interaction ranges.

The research is supported by the U.S. Department of Energy under Grant No. DE-FG02-95ER-14509.